December 2009

GOES-R Hydrology Products

Rainfall Rate, Rainfall Potential, and Probability of Rainfall

What Is GOES-R?

The Geostationary Operational Environmental Satellite - R Series (GOES-R) is the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary Earth-observing systems. Superior spacecraft and instrument technology will support expanded detection of environmental phenomena, resulting in more timely and accurate forecasts and warnings. The Advanced Baseline Imager (ABI), a sixteen channel imager with two visible channels, four near-infrared channels, and ten infrared channels, will provide three times more spectral information, four times the spatial resolution, and more than five times faster temporal coverage than the current system. Other advancements over current GOES capabilities include total lightning detection (in-cloud and cloud-to-ground flashes) and mapping from the Geostationary Lightning Mapper (GLM), and increased dynamic range, resolution, and sensitivity in monitoring solar X-ray flux with the Solar UV Imager (SUVI). GOES-R is scheduled for launch in 2015.

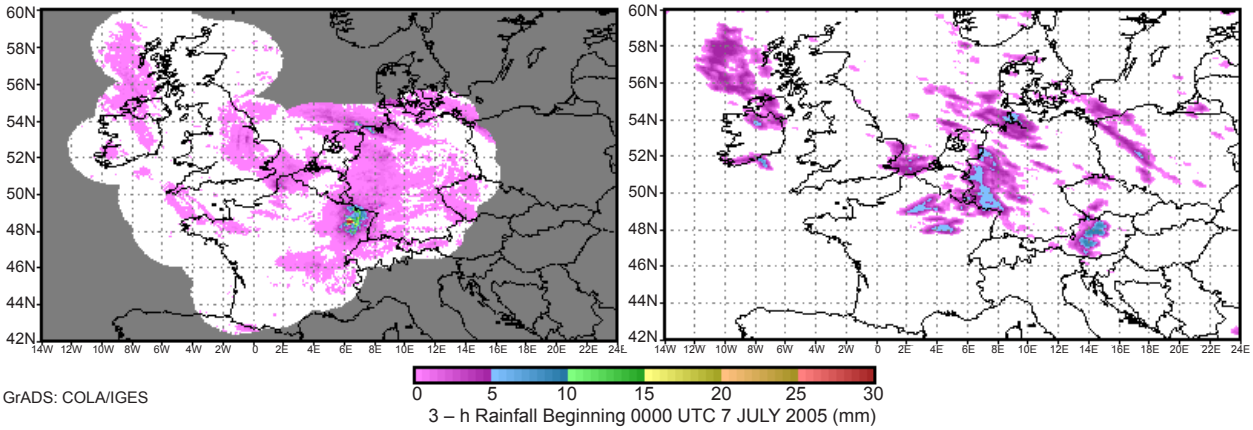
Why Are Rainfall Estimates and Forecasts Important?

Rainfall information is essential to decision-making ranging from short-term heavy rainfall and flood hazard forecasting to long-term assessments concerning agriculture and water resources management. Flood Hazards have the most striking safety and economic impact: According to the United Nations International Flood Initiative (http://www.ifi-home.info), floods affect more than half a billion people each year, causing 25,000 deaths and an average of $50-60 billion in damage annually. In the United States alone an average of 400,000 people are affected by flooding each year with an associated $22 billion in annual damages (http://www.preventionweb.net).

Flooding in Houston during Tropical Storm Allison in June, 2001. More than 35 inches of rain fell in Houston during the storm, killing 41 people and causing more than $5 billion in damage.

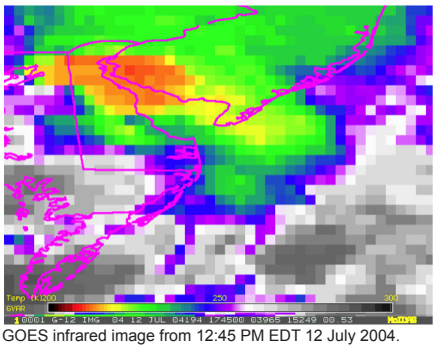
How Will GOES-R Address This Hazard?

Although some parts of the world (including the United States) have extensive networks of ground-based radars and rain gauges, satellites provide a critical source of supplemental information about rainfall. The **Rainfall Rate** product will enhance radar and gauge rainfall information by providing estimates of current rainfall rate over mountainous terrain, and other data-sparse areas where floods often originate, as well as ocean regions for monitoring incoming storms. It will improve upon the current-



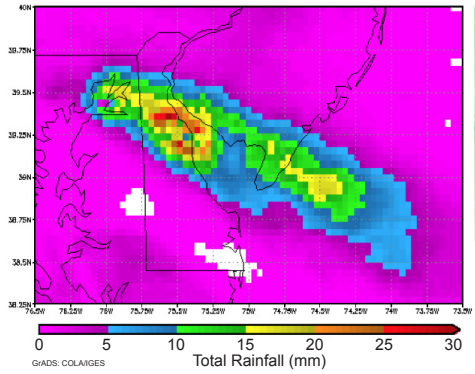
*Comparison of experimental **Rainfall Potential** product, using Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI) proxy data (Far Right), and composite radar data (Near Left), over Western Europe for a 3-hour forecast beginning at 1500 GMT July 8, 2005.*

generation operational **Rainfall Rate** product via enhanced spatial resolution (2 km for the ABI vs 4 km for current GOES) and through the use of data from the new ABI near-IR and IR bands to account for cloud-top properties (phase and particle size) in deriving rainfall rates. The **Rainfall Potential** product will provide extrapolation-based forecasts of rainfall over the subsequent three hours to assist forecasting of potential heavy rain and flooding events, while the **Probability of Rainfall** product will provide the probability of rainfall occurring during the next three hours. **Probability of Rainfall** is important when the occurrence or absence of rain is a more critical piece of information, such as planning outdoor activities, construction, and agriculture.



GOES infrared image from 12:45 PM EDT 12 July 2004.

Cold (red) temperatures on infrared satellite imagery indicate deep, cold thunderstorm clouds with heavy rain.



Satellite-based total rainfall from 11 AM-7 PM EDT 12 July 2004.

GOES-R will use this information to estimate rainfall and thus alert forecasters to potential flooding.

*Simple schematic of **Rainfall Rate** estimation using satellite imagery. The time varying cloud top properties observed in multiple channels by the ABI are used to derive the instantaneous and accumulated rainfall.*

How Do These Products Work?

The **Rainfall Rate** algorithm calibrates data from the visible and infrared portions of the spectrum against rainfall rate information from low earth-orbiting microwave observations using a statistical model. This will represent a step forward from the current-generation algorithm which uses a "one size fits all" calibration for all regions and seasons. The **Rainfall Potential** algorithm extrapolates the current **Rainfall Rate** field forward in time along motion vectors determined by comparing the current and previous **Rainfall Rate** field, then adding up the extrapolated rate fields into three-hour totals. The **Probability of Rainfall** product is based on a statistical model that calibrates the forecasts from the **Rainfall Potentia**l algorithm against the observed occurrence of rainfall.

Research and Development Partners for Hydrology Products

- NOAA National Environmental Satellite, Data and Information Service, Center for Satellite Applications and Research (NESDIS/STAR)
- NOAA/NESDIS Office of Satellite Data Processing and Distribution (OSDPD) Satellite Analysis Branch (SAB)
- Cooperative Institute for Climate and Satellites (CICS) at the University of Maryland, College Park
- City College of New York (CCNY)
- Hampton University

On the Web

http://www.star.nesdis.noaa.gov/smcd/emb/ff/index.php
http://www.nssl.noaa.gov/users/rabin/public_html/nowcast

For More Information, Contact:

GOES-R Program Office
Code 417
NASA Goddard Space Flight Center
Greenbelt, MD 20771
301-286-1355

Jim Gurka, james.gurka@noaa.gov

Steve Goodman, steve.goodman@noaa.gov

What Are The Benefits?

For the past 30 years, analysts from the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) Satellite Analysis Branch (SAB) have provided satellite information to National Weather Service (NWS) operational forecasters to supplement information from gauges and radar. Manual techniques have evolved into more skilled, fully-automated methods that are used by operational forecasters all over the world; for instance, the current-generation **Rainfall Rate** algorithm is used to identify flash flood and landslide risks from landfalling hurricanes and other heavy rain producers in Central America. The improved accuracy and coverage of the rainfall products generated by the ABI will lead to improved forecasting and warning of impending floods, reducing their human and economic cost.

Contributor: Bob Kuligowski – NOAA/NESDIS